IN-SITU CHARACTERIZATION FOR RADIONUCLIDES USING HIGH PURITY GERMANIUM DETECTORS

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	Page:	1 OF 9
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TABLE OF CONTENTS

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1.0 PURPOSE

This operating procedure establishes the methodology for acquisition of field radiation spectral data collected for the purposes of surface media characterization. This procedure describes activities involved in using *in situ* gamma-ray spectrometers. A summary of these activities is included in Appendix 1.

2.0 SCOPE

This procedure applies to all personnel operating *in situ* gamma spectroscopy equipment of the ADCAM architecture (EG&G Instruments) at Rocky Flats Plant (RFP) for the purposes of surface media characterization.

3.0 REFERENCES

1 Source References

3.1.1. Maestro™ II A64-BI Software Operator's Manual, Software Version 1.40, EG&G ORTEC Part No. 761840, Manual Revision B.

3.1.2. Reiman, R.T. 1985. "*In Situ* Gamma Analysis System," Proceedings of the Remote Sensing Technology Symposium, (Las Vegas, NV, USA 1983), Report No. EGG-10282-1057. Las Vegas, NV: EG&G/EM. pp.28-1, 28-24.

3.1.3. Solid-State Photon Detector Operator's Manual, GMX Series, EG&G ORTEC.

3.1.4. Model 92X-PD Detective™ Portable Gamma-Ray Detector and Spectroscopy System Hardware Reference Manual, EG&G ORTEC Preliminary Manual Revision A.

3.1.5. Model 921 Spectrum Master™ High-Rate Multichannel Buffer Hardware Manual, EG&G ORTEC Part No. 761980, Manual Revision A.

3.1.6. Model 671 Spectroscopy Amplifier Operating Manual, EG&G ORTEC Part No. 736840.

3.1.7. Model 659 5-kV Detector Bias Supply and Service Manual, EG&G ORTEC Part No. 740330, Manual Revision C.

3.1.8. Model 4001C Modular System Bin Operating and Service Manual, EG&G ORTEC Part No. 485670.

3.1.9. BLACK MAX™ Power Supply Model 4002E Operating Manual, EG&G ORTEC Part No. 740270, Manual Revision A.

2 Internal References

3.2.1. Environmental Management Operations Procedure, 5-21000-OPS-FO.02, Transmission of Field QA Records.

4.0 LIMITATIONS AND PRECAUTIONS

1 The mast on the vehicle shall not be extended in wind speeds exceeding 35 miles per hour. There are no other specific safety concerns associated with the use of this instrument. However, health and safety concerns within the area the instrument is being used will be addressed in the Site Specific Health & Safety Plan.

2 Use is limited to only qualified personnel as described in Section 5.0.

3 The equipment is limited to collecting information on gamma- and X-ray emitting radioisotopes.

4 The equipment is limited to collecting information from the surface media.

5.0 PREREQUISITES

1 The responsible manager shall ensure that personnel implementing this procedure;

- have a thorough knowledge of gamma-ray spectrometry systems including but not limited to reading the Source References,
- have thorough knowledge of Maestro™ and NuMAl software packages, and
- have documentation of successfully operating gamma-ray spectrometry equipment at two locations under the supervision of a qualified person who has;

- a thorough knowledge of gamma-ray spectrometry,
- read the Source References,
- a thorough knowledge of Maestro™ and NuMAl software packages,
- documented on-the-job training, and
- successfully used the instrument at no fewer than two locations.

6.0 INSTRUCTIONS

NOTE

All completed log entries shall be signed and dated by the individual completing this procedure. Any problems must be reported immediately to the equipment custodian.

1 Obtain the locations to be characterized and sampling height (e.g., the height of the detector) from the Work Plan.

2 Characterization (often but incorrectly referred to as calibration) is not within the scope of this procedure. However, the user must verify that the detector has current characterization data, based on the information

in the characterization log book. Post-usage characterization is acceptable if this is identified in the log book prior to use of the equipment. This step is only required the first time the equipment is used in a day or at the beginning of a shift.

NOTE

To obtain more specific instructions refer to the appropriate user's guide(s) listed in the Reference section.

3 Verify connection/connect the detector OUTPUT (BNC) cable to the AMP IN on the amplifier.

4 Verify connection/connect the detector BIAS SHUTDOWN (BNC) cable to SD or BIAS SHUTDOWN on the bias supply.

5 Verify connection/connect the detector BIAS (SHV) cable to 0-5k HV on the bias supply.

6 Verify connection/connect PREAMP (9 PIN) cable to the PREAMP POWER (9 PIN) on the amplifier.

7 Verify connection/connect DUAL PORT (37 PIN) cable between microprocessor and spectrometer.

8 Review the log book and postings on the equipment. Verify that the current system settings are consistent with the data in the log book or document the changes. This step is required each time the system is disassembled and reassembled (For most cases, the first time the system is set on a given day.) and again at the end of the day.

9 Verify that the spectrometer system is on or turn it on.

10 Verify that the microprocessor system is on or turn it on.

11 Verify that the detector bias supply is on or turn it on.

12 Initiate spectrum acquisition.

13 Record the following in the Log Book or Field Worksheet:

6.13.1. Detector Serial Number.
6.13.2. Acquire Time.
6.13.3. Detector Height.
6.13.4. Sample Number.
6.13.5. Sample Location.
6.13.6. Sample Crew.
6.13.7. Sample Date and Time.
6.13.8. Data file name (ensure that the file name is unique by using the next sequential file number for the detector package).
6.13.9. Current software versions if they have changed since the last entry.
6.13.10. If data are available, document soil type and water content.
6.13.11. Comments on unusual items (e.g., equipment, location, weather, terrain).

14 At the completion of the measurement, record data on magnetic media.

15 Repeat steps 6.1 to 6.14 for each location to be characterized that day.

16 Generate a hard copy of the summary report(s) then sign and date this report, and submit it to the Project Manager for inclusion in the EM records center (see 5-21000-OPS-FO.02, Transmission of Field QA Records).

17 Contact the Project Manager to determine disposition of the field data tape(s).

7.0 DOCUMENTATION

Verification of the completion of this procedure in accordance with the above steps is documented by signing the applicable log entries and summary report. The optical and/or tape files of the analysis are QA records and shall be transmitted to the EM record center (see 5-21000-OPS-FO.02, Transmission of Field QA Records).

APPENDIX 1
Background

The objective of *in situ* gamma-ray spectroscopy is to obtain information on the identity, amounts, and geographic distribution of radioisotopes at RFP. This is accomplished by placing a gamma-ray detector above the ground and measuring the gamma-rays present as a function of energy. The location of the measurement is typically based on a predetermined sampling strategy such as a grid system. The detector's 'field of view' is a function of several factors. A primary factor in determining the 'field of view' is the detector's height above the ground. A 1-meter height (portable field instrument) yields a 'field of view' for 60 keV gamma-rays of approximately 14 meter diameter. A detector height of 7.5 meters (truck mounted instrument) yields a 60 meter diameter for the same 60 keV gamma-rays. The detector's height, as the sampling location, is often governed by the sampling strategies employed.

A basic system consists of a detector, detector bias supply, linear amplifier, pulse height analyzer (PHA), microprocessor, tripod, and positioning equipment. Gamma-rays depositing their energy in the biased detector create electron hole pairs. These pairs are collected as a distribution of charges or pulse representative of the initial gamma-ray energy. The linear amplifier shapes and amplifies the pulse for the PHA. The PHA converts the analog pulse to a digital count and maps the count to a proportional memory location. If that location has a previous count then the PHA simply adds the new to the old and stores the results. (This capability to add counts taken at various times is not used in this procedure.) This results in a histogram of counts versus energy or a gamma-ray energy spectrum.

Each gamma-ray-emitting radionuclide has its own unique gamma signature. This enables the spectroscopist to identify specific radionuclides present within the gamma-ray energy spectrum. The fact that the system has kept track or counted the gamma-rays as a function of energy allows the spectroscopist to quantify those radionuclides present.

It is important to document the parameters of each measurement as well as the measurement itself. This is accomplished using two media, electronic and a hard copy such as a field work sheet. The documentation aids the spectroscopist with the analysis and it can be used to resolve any uncertainties in the measurements.